substantially clears the Van Allen radiation belts, and where the semi-major axis of the intermediate orbit is substantially less than the semi-major axis of a final orbit, and where the inclination of the intermediate orbit is substantially greater than the inclination of the final orbit", "firing the electric propulsion thrusters to raise the orbit of the spacecraft from the orbit achieved by the chemical propulsion thrusters firing step to near geosynchronous orbit by steering the thrust vector both in-plane and out-of-plane while rotating the spacecraft body and steering the solar array to maintain the sun's illumination on the solar array", and "firing selected ones of the chemical and electric propulsion thrusters to achieve final geosynchronous orbit".

Thus, in the present invention, chemical propulsion thrusters are fired to raise the orbit of the spacecraft from transfer orbit to an intermediate orbit where the semi-major axis of the intermediate orbit is substantially less than the semi-major axis of a final orbit, and where the inclination of the intermediate orbit is substantially greater than the inclination of the final orbit. Then, electric propulsion thrusters are fired to raise the orbit of the spacecraft from the intermediate orbit to near geosynchronous orbit, which steers the thrust vector both in-plane and out-of-plane while rotating the spacecraft body. Then, final geosynchronous orbit is achieved by firing selected ones of the chemical and electric propulsion thrusters. This three-part sequence is not disclosed or suggested by the Spitzer et al. patent.

It is stated in the summary section of the Spitzer et al. patent, for example, that "The controller fires the propulsion thruster at apogees of intermediate orbits to successively increase the perigees thereof until the semi-major axis of an intermediate orbit is substantially equal to the semi-major axis of the synchronous orbit, thereby defining an initial transfer orbit for the spacecraft. The controller thereafter continuously fires the propulsion thruster to translate the orbit of the spacecraft from the initial transfer orbit to the synchronous orbit while maintaining the substantial equality of the synchronous semi-major axis and the transfer orbit semi-major axis. This is also stated in the detailed description section of the Spitzer et al. patent.

The recitation that the "controller fires the propulsion thruster at apogees of intermediate orbits to successively increase the perigees thereof <u>until the semi-major axis of an intermediate orbit is substantially equal to the semi-major axis of the synchronous orbit</u>, thereby defining an initial transfer orbit for the spacecraft" is clearly not what is recited in Claims 1 and 23, nor is there any specific disclosure or suggestion regarding what is recited therein. [Emphasis added] Claims 1 and 23 state that the chemical propulsion thrusters are fired to raise the orbit of the spacecraft from transfer orbit to an <u>intermediate orbit where the semi-major axis of the intermediate orbit is substantially less than the semi-major axis of a final orbit</u>.

Thus, in accordance with the teachings of the Spitzer et al. patent, the semi-major axis of an intermediate orbit is substantially equal to the semi-major axis of the synchronous orbit, whereas in the present invention, the semi-major axis of the intermediate orbit is substantially less than the semi-major axis of the final orbit. It is respectfully submitted that this first aspect

of the presently claimed invention is clearly different from the teachings of the Spitzer et al. patent, and that the Spitzer et al. patent does not disclose or suggest this aspect of the present invention.

In the present invention, electric propulsion thrusters are fired to raise the orbit of the spacecraft from the intermediate orbit to near geosynchronous orbit, which steers the thrust vector both in-plane and out-of-plane while rotating the spacecraft body. This is not the case in the Spitzer et al. system.

A detailed reading of the Spitzer et al. patent reveals that the word steer is not used therein. Also, while the Spitzer et al. patent discusses orienting the spacecraft, there is no disclosure or suggestion therein regarding steers the thrust vector both in-plane and out-of-plane while rotating the spacecraft body, as is recited in Claims 1 and 23. Furthermore, there is no disclosure or suggestion in the Spitzer et al. patent regarding raising the orbit of the spacecraft from the intermediate orbit to near geosynchronous orbit.

The Examiner has stated several times in the Office Action that the Spitzer et al. patent discloses steering the thrust vector both in plane and out of plane while rotating the spacecraft body, citing column 7, line 56 through column 8, line 34. This portion of the Spitzer et al. patent discusses Figs. 7-9. Comparing Figs. 7-9 of the Spitzer et al. patent with Figs. 3 and 4 of the present application will reveal the difference between the present invention and what is disclosed in the Spitzer et al. patent,

Note that the velocity vectors shown in Figs. 7-9 of the Spitzer et al. patent all point in the same direction. I contrast, Figs. 3 and 4 of the present application show that the velocity vectors are along or tangential to the orbit of the spacecraft. As was stated in the Background section of the present application, the Spitzer et al. technique adjusts the inertial attitude periodically <u>while maintaining a fixed direction of electric propulsion thrust firing throughout each orbit</u>. [Emphasis added] Thus, it is respectfully submitted that the Spitzer et al. patent does not steer the thrust vector both in-plane and out-of-plane while rotating the spacecraft body as is presently claimed. This also addresses the second point in the Examiner's "Response to Arguments" section of the Office Action.

With regard to the first point raised in the Examiner's "Response to Arguments" section, as to the limitation "firing chemical ... than the inclination of the final orbit", the Examiner stated that he "believes that the main contention with this limitation is that applicants take the position that Spitzer et al does not disclose using both chemical and electrical thrusters". This is not the assertion of Applicant. Clearly, the Spitzer et al. patent discloses the use of both chemical and electrical thrusters. It is respectfully submitted that the manner in which these thrusters are employed, the manner in which the spacecraft is raised from the transfer orbit to geosynchronous orbit, and the nature of the spacecraft disclosed in the present application and the Spitzer et al. patent are different. This was argued in the previous response but was apparently not appreciated by the Examiner. Hopefully, the present arguments will provide a

better understanding of the differences between the present invention and the teachings of the Spitzer et al. patent.

It is also respectfully submitted that the arguments made in the prior response along with the present arguments are sufficient to indicate that the present invention, as claimed, is not disclosed or suggested by the Spitzer et al. patent.

The basic attitude configuration utilized in the present invention maintains a fixed attitude relative to the thrust vector (steered) and the sun. This spacecraft attitude and the resultant thrust direction rotate in inertial space. When near apogee the thrust vector might be along the velocity vector at apogee but when the spacecraft is not at apogee the thrust vector is generally not aligned with the velocity vector at apogee.

The Spitzer et al. patent teaches that the spacecraft's attitude during the electric orbit raising mission (including all propulsion thrust maneuvers) is maintained in an "inertial attitude." Those skilled in the art recognize that "inertial attitude" refers to a fixed attitude in a non-moving coordinate system. The definition of inertial attitude is discussed in Section 18.3 of "Attitude Determination and Control" (James R. Wertz, D. Reidel Publishing Company, 1978). Wertz identifies a basic configuration of "inertially referenced spacecraft which maintain a nearly fixed attitude relative to a stellar target." Since the attitude is fixed the thrust vector must also be fixed in inertial space. Spitzer et al. constrains this thrust attitude even when not at apogee to still be generally along the direction of the velocity vector at apogee.

From the above arguments and those contained in the previous response, and with specific regard to independent Claim 1, it is respectfully submitted that the Spitzer et al. patent does not disclose or suggest the steps of "firing the chemical propulsion thrusters at apogees of intermediate orbits, starting from the transfer orbit initiated by the launch vehicle, to successively raise perigees of the orbit until the spacecraft perigee substantially clears the Van Allen radiation belts, and where the semi-major axis of the intermediate orbit is substantially less than the semi-major axis of [the] a final orbit, and where the inclination of the intermediate orbit is substantially greater than the inclination of the final orbit", "firing the electric propulsion thrusters to raise the orbit of the spacecraft from the orbit achieved by the chemical propulsion thrusters firing step to near geosynchronous orbit by steering the thrust vector both in-plane and out-of-plane while rotating the spacecraft body and steering the solar array to maintain the sun's illumination on the solar array" and then "firing selected ones of the chemical and electric propulsion thrusters to achieve final geosynchronous orbit" as is recited therein.

In view of the above, it is respectfully submitted that Claim 1 is not disclosed or suggested by the Spitzer et al. patent. Accordingly, withdrawal of the Examiner's rejection and allowance of Claim 1 is respectfully requested.

Dependent Claims 2-22 are considered patentable based upon the patentability of Claim 1 from which they depend. Therefore, withdrawal of the Examiner's rejection and allowance of Claims 2-22 is respectfully requested.

Independent Claim 23 contains substantially the same limitations as are recited in Claim 1 (which are implemented in a processor) and is considered patentable over the Spitzer et al. patent for the same reasons as Claim 1. Therefore, it is respectfully submitted that Claim 23 is not disclosed or suggested by the Spitzer et al. patent. Accordingly, withdrawal of the Examiner's rejection and allowance of Claim 23 is respectfully requested.

Dependent Claims 24-29 are considered patentable based upon the patentability of Claim 23 from which they depend. Therefore, withdrawal of the Examiner's rejection and allowance of Claims 24-29 is respectfully requested.

The prior art made of record and not relied upon is considered pertinent to Applicant's disclosure to the extent indicated by the Examiner.

Attached hereto is a marked-up version of the changes made to claims by the present amendment. The attached page is captioned "Version with markings to show changes made."

In view of the above, it is respectfully submitted that Claims 1-29 are not anticipated by, nor are they obvious in view of, the cited patents, taken singly or together, and are therefore allowable. Accordingly, it is respectfully submitted that the present application is in condition for allowance. Reconsideration of this application and allowance thereof are earnestly solicited. It is again respectfully submitted that this response does not require further searching by the Examiner and that this response places this application in condition for allowance, or in any event, in better condition for consideration on appeal.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS

The following Claims have been amended as indicated.

1. (Twice amended) A method for raising a spacecraft launched into a transfer orbit about the Earth from the transfer orbit to a geosynchronous orbit, comprising the steps of:

launching a spacecraft having chemical and electric propulsion thrusters and a solar array;

firing the chemical propulsion thrusters at apogees of intermediate orbits, starting from the transfer orbit initiated by the launch vehicle, to successively raise perigees of the orbit until the spacecraft perigee substantially clears the Van Allen radiation belts, and where the semi-major axis of the intermediate orbit is substantially less than the semi-major axis of [the] a final orbit, and where the inclination of the intermediate orbit is substantially greater than the inclination of the final orbit;

firing the electric propulsion thrusters to raise the orbit of the spacecraft from the orbit achieved by the chemical propulsion thrusters firing step to near geosynchronous orbit by steering the thrust vector both in-plane and out-of-plane while rotating the spacecraft body and steering the solar array to maintain the sun's illumination on the solar array; and

firing selected ones of the chemical and electric propulsion thrusters to achieve final geosynchronous orbit.

23. (Twice amended) A system for raising a spacecraft launched into a transfer orbit about the Earth from the transfer orbit to a geosynchronous orbit, comprising:

a spacecraft comprising chemical and electric propulsion thrusters and a solar array;

a processor onboard the spacecraft for:

firing the chemical propulsion thrusters at apogees of intermediate orbits, starting from the transfer orbit initiated by the launch vehicle, to successively raise perigees of the orbit until the spacecraft perigee substantially clears the Van Allen radiation belts, and where the semi-major axis of the intermediate orbit is substantially less than the semi-major axis of [the] a final orbit, and where the inclination of the intermediate orbit is substantially greater than the inclination of the final orbit;

firing the electric propulsion thrusters to raise the orbit of the spacecraft from the orbit achieved by the chemical propulsion thrusters firing step to near geosynchronous orbit by steering the thrust vector both in-plane and out-of-plane while rotating the spacecraft body and steering the solar array to maintain the sun's illumination on the solar array; and

firing selected ones of the chemical and electric propulsion thrusters to achieve final geosynchronous orbit.